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3.	3	,,	1930 (none).
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2, 1921, 5 ,,
3, 1922, 4 ,,
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As number 4 of Vol. 3 was printed as "Volume 4" and number 1 of Vol. 4 as "Volume 5" it would appear from an inspection of a complete set that Volume 4 comprised only a number 4 and that there were two issues of Volume 5, No. 1.

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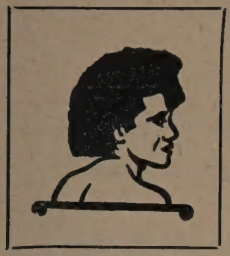

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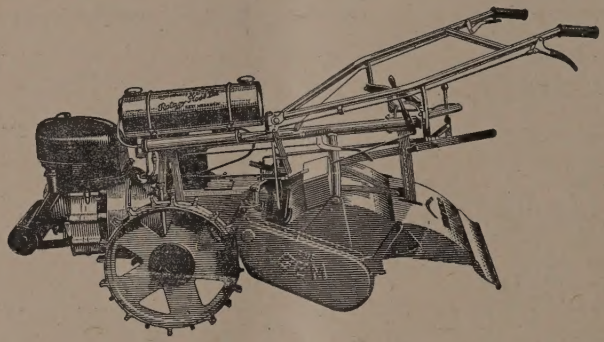

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ANIMAL HUSBANDRY . . .

THE TOXICITY OF CREEPING INDIGO ("INDIGOFERA ENDACAPHYLLA")

BY W. J. A. PAYNE AND R. K. NAIDU

"Indigofera endacaphylla" or creeping indigo was introduced into the Colony in January, 1950. Preliminary investigations have shown that it is a useful pasture legume, drought resistant in the dry zone and growing very well in the wet zone. At Sigatoka it has been shown to mix well with guinea ("Panicum maximum") and para ("Brachiaria mutica") grasses, that it is very palatable to both dairy cattle and goats, and that it flourishes under a system of monthly rotational grazing. It sets viable seed at Sigatoka but not in the wet zone.

Unfortunately overseas workers have reported that under certain conditions it is toxic to most domestic animals. Emmel and Ritchey (1941) first reported that it was toxic to cage fed rabbits. Some years later Nordfeldt and Younge (1949) in Hawaii reported that it might cause reproductive disturbances in cattle and that its toxicity was being investigated. Intensive investigations were made in Hawaii and Rosenburg and Palafox (1950) reported that it caused toxicity in chicks, and that inclusion of it in a chick meal depressed growth. Nordfeldt, *et al.* (1952) then showed that if fed in large amounts to breeding cattle it caused abortions and stillbirths and that if fed as the sole diet to sheep and rabbits it caused death. Hawaiian workers did however point out that small amounts of creeping indigo must be eaten by stock in many Hawaiian pastures without noticeable ill effects, and Jaganathan (1953) has also reported from Ceylon that although two six months old Sinhala bull calves lost weight when fed 10 pounds of creeping indigo per day, cattle and goats graze lands where this legume is grown as a mixed cover crop and no ill effects have ever been reported. Workers in Puerto Rico have concentrated on searching for the toxic principle in the legume and Morris and Pagan (1953) recently reported that they have isolated the toxic principle and that it is a substance known as hitagenic acid. Other workers in Puerto Rico have shown that if death does not occur the damage to the reproductive tract of guinea pigs caused by feeding the legume is not permanent and that the animals will breed normally once the feeding of creeping indigo is discontinued (Warmke and Freyre (1953)).

At Sigatoka one pasture containing a strip of creeping indigo has been rotationally grazed by the station dairy herd since 1950 and no ill effects have been noticed. In 1952 a goat was tethered on a pure stand of creeping indigo for three weeks. This animal grew normally and did not react in any abnormal manner to the diet. These observations do not of course prove that creeping indigo is not toxic to domestic livestock in Fiji but only that no toxicity was demonstrated under the particular conditions prevailing at Sigatoka.

As creeping indigo is such a promising legume and the Department of Agriculture would like to be able to distribute plant material and seeds to farmers, and the field evidence of toxicity from Hawaii, Ceylon, and Sigatoka conflicts with the experimental evidence from Hawaii, Ceylon, and Puerto Rico, it was decided to conduct a toxicity trial using the methods outlined by Rosenburg and Zoebisch (1952) in Hawaii. These workers used chicks as experimental animals, and found that when creeping indigo was fed at a 5 per cent level the growth of the chicks slowed down and that within 21 days the chicks were exhibiting symptoms of paralysis, first of the neck, then of the legs and wings, followed eventually by death.

SIGATOKA EXPERIMENT.

EXPERIMENTAL PROCEDURE.

It was not possible to use day old chicks as there are no brooding facilities at Sigatoka. Unsexed five week old White Leghorn chicks were imported from Koronivia on June 2nd. Unfortunately they could not be immediately placed on the experimental rations, and they were all fed the same standard ration until June 21st.

The chickens were then divided into four groups, sixteen chickens in each group. Chicks for each were selected at random from chickens of approximately the same weight. Each group was then fed a ration that only differed in its leaf meal content. Ration I contained 5 per cent Nadi blue grass (*Dichanthium caricosum*) meal, Ration II 5 per cent creeping indigo meal, ration III 10 per cent creeping indigo meal, and ration IV 5 per cent vaivai (*Leucæna glauca*) meal. All the meals were made from young leafy plant material, oven dried at 65°C, and pounded into a meal. The composition of the experimental rations are shown in Table 1.

Chemical determination of crude protein showed that the protein content of the rations did not differ to any appreciable extent.

The rations were fed as a mash twice daily at 7 a.m. and 4 p.m. Coral sand and water were always available and as from the 3rd of July skim milk was fed *ad lib*.

Each bird was weighed for three successive days in each week to the nearest gramme, food was weighed in and out of the pens daily, and each bird was inspected daily for symptoms of toxicity, and apparent health was scored on a score card.

Unfortunately the experiment had to be ended after it had run for three weeks owing to an outbreak of cannibalism that could not be controlled. Cannibalism was worst in group IV but was present in all groups.

RESULTS.

Details of growth, appetite, and health over the three weeks experimental period are given in Table 2. The chickens in group III definitely grew slower than those in the other groups, but they did not appear to be suffering from any other symptoms of toxicity and scored better on the health score than groups II and IV. There were three deaths in Group II, two of the dead chickens having abnormalities in the digestive tract. There were also two deaths in Group IV but both these were due to " cannibalism ". The slightly poorer growth of the chickens in group IV might also have been due to " cannibalism " as it was worst amongst this group.

TABLE 1.

EXPERIMENTAL RATIONS FED TO THE CHICKENS.

	Ration I 5% *Nadi blue grass*	*Ration* II 5% *indigo*	*Ration* III 10% *indigo*	*Ration* IV 5% *vaivai*
	parts	*parts*	*parts*	*parts*
Maize meal ..	57	57	57	57
Coconut meal ..	10	10	10	10
Peanut meal ..	5	5	5	5
Bean meal ..	5	5	..	5
Meat meal ..	10	10	10	10
Skim buttermilk powder ..	5	5	5	5
Dried grass ..	5	..	..	..
Dried indigo ..	..	5	10	..
Dried vaivai ..	..	..	..	5
Mineral mix ..	3	3	3	3
Cod liver oil ..	4 table spoonfuls per 100 lb.	As I	As I	As I

Rosenburg and Zoebisch (1952) reported that even at the 5 per cent level indigo caused toxic symptoms that physically resembled the symptoms of Newcastle disease. No chickens on any group at Sigatoka showed these symptoms, though they were older than the chickens that Rosenburg and Zoebisch used.

TABLE 2.

LIVEWEIGHT GAIN, APPETITE AND HEALTH OF THE CHICKS.

Treatment.	Liveweight gain 18.6 — 9.7 (gm.)	Amount feed eaten. (lb.)	Av. No. days healthy.†
I 5% grass meal ..	286 (16)*	48.6	18
II 5% indigo meal ..	282 (13)	40.6	17
III 10% indigo meal ..	176 (16)	42.3	18
IV 5% vaivai meal ..	248 (13)	47.8	16

* The figures in brackets refer to the number of chickens alive at the end of the trial.

† The trial lasted 19 days, so that the maximum number of days that the average bird could be healthy was 19.

CONCLUSIONS.

The experiment was inconclusive because although there were some indications that the creeping indigo meal was having adverse affects on the chicks, three chickens dying

in group II and growth being retarded in group III, the indications were not clear, as no chicks died in group III or showed any of the toxicity symptoms decribed by the Hawaiian workers, nor was growth depressed in group II chicks.

In view however of the results that have been obtained overseas particularly in Hawaii where the general environmental conditions are quite similar to Fiji it is not recommended that seeds or planting material of creeping indigo be released for farmers to include in their pastures until further evidence has been obtained on the degree of toxicity of this plant when grown in Fiji.

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REPORT ON A TOUR OF RESEARCH INSTITUTES IN ENGLAND AND SCOTLAND

By W. J. A. PAYNE

During September, 1952, I visited many of the principal Research Institutes and University Departments of Agriculture in England and Scotland where animal husbandry investigations are being conducted. During this tour I was able to meet many scientists working on problems of interest to a tropical animal husbandman, as well as gain first hand information on current investigations.

I also spent the months of November and December working at the Hannah Dairy Research Institute in Scotland on heat physiology problems and in January 1953 I spent ten days in the Agricultural Physiology Department of the University of Cambridge, and at the Artificial Insemination Centre managed by Cambridge and District Cattle Breeders Ltd., learning the technique of deep freezing semen. In addition I visited many private farms, a tractor plant, a milking machine assembly plant and I attended two scientific conferences, and the Dairy Show.

It would not be possible to describe in detail all the investigational and development work that I saw and I am restricting my observations to work that I think may be of general interest to farmers in Fiji.

INSTITUTES VISITED.

I have grouped the principal institutes visited together according to their geographical position, and they are listed below :—

London area—
- Rothamsted Experimental Station.
- Grassland Research Station, Hurley.

Reading area—
- National Institute for Research in Dairying.
- Commonwealth Bureau of Dairy Science.
- Department of Agricultural Chemistry, Reading University.
- Jeallots Hill Research Station.

Cambridge area—
- School of Agriculture, Cambridge University.
- Unit of Animal Reproduction, Animal Research Station.
- Artificial Insemination Centre, Cambridge and District Cattle Breeders Ltd.

West Midlands area—
- Grassland Research Station, Stratford-on-Avon.

Edinburgh area—
- Institute of Animal Genetics.
- Commonwealth Bureau of Animal Breeding and Genetics.

Animal Breeding Research Organisation.
Poultry Research Centre.

Aberdeen area—

Commonwealth Bureau of Animal Nutrition.
Rowett Research Institute.

Glasgow area—

Hannah Dairy Research Institute.

West of Scotland Agricultural College.

It is not however convenient to discuss the work that is being done at these institutes on a geographical basis, and the animal husbandry work at all of them that may be of interest to the farmer in Fiji has been grouped under four headings, animal breeding, animal nutrition, heat physiology and management.

ANIMAL BREEDING INVESTIGATIONS.

Animal breeding investigations are concentrated at Edinburgh and Cambridge.

At Edinburgh, the Director of the Commonwealth Bureau of Animal Breeding and Genetics who had recently toured India, Pakistan and Ceylon, informed me of many interesting details concerning the livestock industry of those countries, that may be of interest to the farmer in Fiji. He considered that the quality of much of the stock is excellent. The outstanding dairy cattle breeds are the Sahiwal and the Red Scindi The Sahiwal with average yields of 5-600 gallons per lactation on the good farms is the best yielder, but it is not so hardy as the Red Scindi. European type crossbreds (mainly Friesians) also give good yields, but there is more difficulty in rearing the calves, and the adult stock require better quality feed. The best dual purpose work-milk breed is the Thari or Tharparkar. Herds of this breed usually average 200 gallons per lactation, but yields of 1,000 gallons have been recorded and the breed is probably capable of great improvement. In many parts of India the buffalo is more important than the dairy cow as a milk producer. The best known breeds are the Murrah, Nili and Ravi, and in the best herds yields of 4-500 gallons of 7 per cent butterfat testing milk are quite normal, and lactations as high as 1,100 gallons have been recorded. Very little breeding work is being done with the buffalo. There is surprisingly, a considerable development of artificial insemination services in most provinces. The peasants were at first sceptical but have now accepted artificial insemination as a normal method of reproduction. This suggests that it might be used in Fiji with success in certain areas. Apart from cattle and buffaloes, sheep are important. In the north they are usually kept for wool but the mutton quality is surprisingly good. In Mysore there is a very good mutton type sheep the " Bannur ". This animal is called the " Southdown " of India and produces an 80-90 pound carcass at two years of age. Poultry are also important and the Rhode Island Red and White Leghorn breeds appear to predominate. In Ceylon very good results have been obtained with these two breeds, as hatchability has been 88 per cent, and there has been a low mortality despite the fact that no external source of heat is used in brooding.

The Animal Breeding and Research Organisation at Edinburgh is a post-war organisation, and as animal breeding is essentially a long term occupation, there is as yet little to report. The Organisation owns farms where dairy cattle, Large White pigs, and hill sheep are being bred. They are collecting sets of fraternal and identical twins for investigational work.

The Institute of Animal Genetics also houses the genetics laboratory of the Animal Breeding and Research Organisation. A great deal of fundamental genetical work is being done on the effect of environment either in producing mutations or in influencing the action of genes, and experiments on producing animal polyploids (that is animals with more than the normal number of chromosomes) are also taking place. For the investigation of genetic mechanisms small fast breeding species are being used, as experiments with farm animals would be more expensive in terms of time, space, labour and money. Although many of these experiments would appear to be very academic they may be of the greatest utility to the practical animal breeder by gaining for him knowledge of genetic mechanisms.

A survey of 20,000 cows has demonstrated the smallness of genetic improvement. In a small closed herd with no progeny testing the rate of probable genetic improvement would be 0.6 per cent per annum rising to 1.5-2 per cent per annum if progeny testing is introduced. This work once again demonstrates that it is unlikely that we are going to obtain any spectacular improvements in productivity in local herds by utilising familiar breeding techniques. In Great Britain the main differences in productivity between herds is due to management, and an attempt is to be made to measure these differences by using fraternal twin calves, and placing one of a set in a herd where the management is known to be good and one in a herd where it is thought to be poor.

Research students in the Institute have been analysing records from two tropical animal breeding centres, one the Shika Stock Farm in Nigeria where White Fulani and Sokoto Cattle are being bred, and the other the Hope Stock Farm in Jamaica where a new type of tropical Jersey is in the process of evolution. The average milk yield of the Nigerian cattle is around 200 gallons per lactation and unlike European type stock the yield has been highest in the first lactation.

At Cambridge a group of workers under the leadership of Dr. J. Hammond are investigating many problems concerned with the breeding of livestock. Having helped to pioneer artificial insemination and so increasing the productivity of the best bulls, Dr. Hammond is now investigating increasing the productivity of the very best cows. At present a first class animal can only normally produce one calf a year but is capable of producing many more eggs. If the cow can be made to superovulate or produce many eggs at one time and then these eggs are washed out of the cow's reproductive tract it should be possible to place them in "scrub" cows that would only act as live incubators. Fertilisation could theoretically take place before or after implantation in the incubator cow. Cows are being made to superovulate by the use of hormone injections and as many as 20 eggs can be obtained from a cow at one time. A technique for washing out the eggs has also been developed, but it has not yet been found possible to implant the eggs successfully in the incubator cows through the cervix using the same technique as in artificial insemination. The egg can be placed in the incubator cows' womb using a surgical technique but of course this is quite impracticable under farm conditions. The reason why the egg cannot be placed through the cervix is that if this is done infection results and the developing fœtus dies. Investigations are now being conducted to see if any aseptic method of implantation can be developed that could be used on the farm.

It has been shown that not only will the adult cow superovulate but also the young calf. This is important because one of the major difficulties in dairy cattle breeding is the time elapsing from one generation to the next. If eggs can be obtained from young calves the whole breeding process could be speeded up using the implantation technique. These experiments do not have any immediate practical implications for farmers in the tropics, except that the time is approaching when it will be possible to import eggs and sperm instead of live cattle. This may ultimately be of the greatest importance to farmers in Fiji.

It would be very desirable to import new types of cattle from other parts of the tropics, but unfortunately quarantine restrictions make it impossible at the present time, as Fiji is fortunate in being free of tropical animal disease and naturally we wish to keep it that way. A new technique that has been developed at Cambridge might however make it possible to import semen from other parts of the tropics. This semen could then be artificially inseminated in local cattle in order to grade them up to tropical types. This new technique is the deep freezing of semen. At artificial insemination centres semen is generally diluted with a medium containing egg-yolk and stored for several days, but a new technique has been discovered of deep freezing semen at—79° C, and at this temperature when treated with the proper dilutents it will apparently keep for indefinite periods. The temperature of—79° C is obtained by

using solid carbon dioxide which is very cheap in Britain, and the technique is both simple and does not require large amounts of expensive equipment. I spent ten days learning the technique at Cambridge and it could certainly be applied in Fiji if supplies of solid carbon dioxide were available, or some mechanical method of obtaining temperatures of—79° C could be organised.

Using this technique semen could be collected from Indian dairy breds such as the Red Scindi or Sahiwal in India or Pakistan, stored until such time as it was known that it was free of all transmittable disease, then air freighted to Fiji and stored in Fiji until it was required for the insemination of local cows. In this way temperate zone stock could be graded up to tropical type without any bulls being imported into the country. An organisation controlled by a large British firm of stock-breeders has already been set up in Pakistan to store and export Red Scindi and Sahiwal semen and the whole question would merit investigation by Fiji dairy farmers, as there is no doubt that the present temperate type stock are not fully acclimatised to the country.

ANIMAL NUTRITION INVESTIGATIONS.

At Reading it has been shown that sorghum is a satisfactory cereal for inclusion in the ration of fattening pigs, and that its feeding value is approximately the same as that of maize. The same workers have shown that it is better to feed a mixture of cereal products and that the ration should contain no more than 50 per cent of any one cereal. They have also investigated the feeding value of another tropical product conophor cake meal made from the plant *Tetracarpidium conophorum*—and they have found that it is as palatable and useful a feed as peanut meal, and that it will replace up to 10 per cent of fish meal in the ration of young pigs.

At Reading, Cambridge, and Aberdeen, experiments are being conducted on the role of protein in the nutrition of pigs and poultry. It is now realised that the special value of protein of animal origin does not come entirely from its amino-acid structure, but is also derived from a group of vitamins associated with it and now known as the animal protein factor or "A.P.F.". Some or all of the ingredients of "A.P.F." are essential for the production of viable young but not necessarily for growth though the evidence on this is confusing. Some of the constituents of "A.P.F." remain unknown but it has been shown that Vitamin B12 is one of them. The very young and pregnant animals are most in need of "A.P.F.", and it has been shown that the adult animal, particularly if it is a ruminant is usually able to synthesise most or all of the constituents of "A.P.F." in its own digestive tract.

The practical importance of these findings in countries such as Fiji where animal protein is scarce and expensive are considerable. At Cambridge it has been shown that feeding stuffs of animal origin can be omitted from the rations of fattening pigs once they are 90-100 pounds liveweight, and that peanut meal will replace a large part of the fish meal in a fattening ration after weaning, but that it is necessary to feed more protein of vegetable origin than the animal protein that it replaces. At Aberdeen it has been shown that soya bean is a vegetable protein of exceptional value. The most valuable sources of "A.P.F." are raw liver, liver meal, dried whole milk, fish solubles, cow dung, and fish and meat meal. At Aberdeen it was suggested to me that pigs managed on a deep litter system would automatically pick up some "A.P.F." and possibly some antibiotics from the deep litter. This possibility will be investigated at Sigatoka.

Experimental evidence has rapidly accumulated on the feeding of antibiotics which appear to increase growth rate in pigs and poultry. They also markedly improve the growth rate of runt pigs and at Reading it has been shown that a ration containing no animal protein plus antibiotic is equivalent to a diet containing 10 per cent fish meal and is superior to one containing only vegetable protein.

An important experiment on beef cattle feeding at Cambridge has shown that the nutrition of the animal at the calf stage

influences the development of the animal throughout its life. A little good feed fed to an animal in the calf stage is of a great deal more importance than a lot of good feed fed to a larger animal. The results from this experiment show that it is an unwise policy to feed calves at too low a nutritional level in order to economise in the cost of feeding stuffs. I blieve that this is particularly true in the tropics.

With the co-operation of Dr. Pirie of Rothamsted, staff of the Grassland Research station at Stratford-on-Avon are working out a method of extracting protein from leaves. The method used is to macerate the fresh leaf material, express the juice from the macerated material, and separate the protein from the juice. If an economic method of extracting leaf protein can be worked out this may ultimately be of the greatest importance in the tropics. The extracted protein concentrate has been fed to poultry and it appears to replace fish meal in the ration.

At Reading and Jealotts Hill silage making is being studied extensively. It would appear that there are no fundamental differences in the technique of silage making in the tropics or the temperate zone, and that results from these stations with slight modifications would be applicable in the tropics. At Reading it has been shown that in experimental work using small silos, these should be no less than 42 inches in diameter.

HEAT PHYSIOLOGY INVESTIGATIONS.

At the Hannah Dairy Research Institute the reactions of dairy cattle to high temperatures and humidities are being investigated. The work is only now in a preliminary stage and no findings that are of practical utility to a farmer in the tropics have yet been made. Histological investigations at the same Institute have shown that both temperate and tropical type cattle possess sweat glands, but that the secretion of these glands differs markedly from that of human sweat glands.

At the Poultry Research Centre in Edinburgh the reaction of poultry to high temperatures and humidities is being studied. It is encouraging that they have found that the heat tolerance of temperate type poultry depends as much on the degree of acclimatisation as on the inherited abilities of the birds. This suggests that we should be able to build up an economic poultry industry in Fiji using temperate type breeds. They have also shown that short daily periods of extreme heat stress reduces egg weight more than long periods.

ANIMAL MANAGEMENT INVESTIGATIONS.

At the National Institute for Research in Dairying at Reading the milking rate of dairy cows is being investigated. The main factors controlling milking rate appear to be the effective size of the teat orifice, and the pressure difference between the milking machine vacuum and the internal udder pressure. Preliminary experiments show that milk liners differ in their maximum rate of milk extraction, and more markedly in their ability to remove the last 20 per cent of available milk from the udder, but no evidence has been found to support the theory that the time required to milk a cow can be reduced by any training process.

At the Hannah Dairy Research Institute it has been shown that the method of grazing known as close folding increases production per acre by 20-40 per cent as against normal rotational grazing. At Sigatoka we have been following a crude method of close folding for three years and we have the impression but no expermiental evidence that this method of grazing gives similar increases in productivity in Fiji.

Nitrogenous fertilisers are being used extensively on grassland in all parts of Britain and yields have been increased very greatly. There is no doubt that pasture yields and the quality of the pasture could be greatly improved in Fiji by the use of nitrogenous fertilisers, as preliminary trials during the last four years at Sigatoka have shown.

In general, British milking machinery is too elaborate and expensive for Fiji farmers but there are many new developments in refrigeration and sterilisation that are of interest. Refrigeration is absolutely essen-

tial on Fiji dairy farms if the liquid milk market is to be expanded. Several British firms are manufacturing milk bulk-holder refrigeration systems and these would appear to have a future in Fiji. Of the other types of farm refrigeration the ice-block type is probably the most efficient but it might not be so suitable for Fiji conditions where there are no mains electricity supplies.

Increased liquid milk sales would demand improved sterilisation of equipment and it is probable that under Fiji conditions where the general interest and ability of the labour is poor, that steam sterilisation is more desirable than chemical sterilisation. Farms with electricity can use most economically the 1 kw heat storage block steam sterilisers that provide both steam and 20 gallons of hot water per hour. Farms without electricity, and these are certainly more numerous in Fiji, could use a new type of oil fired furnace that will produce both steam and hot water and will burn diesel, kerosene, or used sump oil.

At Aberdeen and at Cambridge investigations are being made into the effect of temperature on the survival of young pigs, and in the number that are " laid over ". It has been shown that young pigs loose heat very rapidly at birth and that it is essential to keep them warm. If they are warm they are more active, and if they are active they are not so likely to be laid on. It is quite possible that even in Fiji in the winter time new born pigs on concrete floors cool down too rapidly thus increasing the chance of their being " laid over ".

ACKNOWLEDGMENTS.

I wish to thank the Director of Agriculture, Fiji, and the Government of Fiji for making it possible for me to visit the many Institutes in England and Scotland and all the personnel in the various organisations and institutes that I visited who gave freely of their valuable time and advice and who received me so hospitably.

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ECONOMIC BOTANY . . .

THE COLLECTION OF PLANT SPECIMENS

BY J. W. PARHAM

The Botany Laboratory received over one thousand specimens for identification during 1954. Many of these specimens were very poor in quality and were quite often either difficult or impossible to identify. A plant cannot be named accurately from a few old and decayed leaves and the time spent trying to identify, even approximately, such poor material is often considerable. The following note has been prepared to describe the type of specimen which should be collected and the way in which it should be treated if it is to be of any use for identification purposes. It is realised that most people who send specimen into the Laboratory for identification do so for a special reason—the plant may be a weed on their property or it may be a grass which has proved successful and about which they require further information. The first part of this note has been prepared for those who wish to collect a suitable specimen for identification and the second part of the note has been prepared for those who wish to make collections for themselves and who would like to know a simple but satisfactory method of preparing their specimens.

1. THE COLLECTION OF SPECIMENS FOR IDENTIFICATION.

1. *The type of specimen to be collected*—The first and most important requirement is to collect a good specimen as this greatly assists identification and saves a lot of time for all concerned. **All plant specimens must have flowers** and, if possible, fruits, as well as leaves. The flower is most important as the identification of most plants is based on the structure of the flower. Specimens without flowers are completely useless and it is, in nearly all cases, impossible to identify a plant from a specimen which consists of leaves only.

A good tree specimen consists of a small branch of the tree with mature leaves, flowers and, if they are available, fruits. When the specimen is collected it should be cut with a sharp knife or with a pair of secateurs so that the least possible damage is done to the tree from which the specimen is taken.

A grass or small herb specimen should consist of the whole plant—root, stem, leaves, flowers and fruit. In the case of large grasses the flower, a portion of the stem, and the root system should be collected. Large herbs or shrubs should be treated in the same way as trees. Examples of good tree, herb and grass specimens are represented in Figure 1 (*c*), (*d*), and (*e*).

2. *Field Notes*—Each specimen should have a few notes attached to it giving the common name (if known), collector, Island or Province, locality, habitat (i.e. roadside, rocky bank, seashore, etc.), height of the tree or plant from which the specimen was taken, any special notes and the date of collection. Figure 2 depicts one of the field labels used in the Botany Laboratory. The label is filled in at the time the specimen is collected and is put in the press on the same sheet as the specimen. If more than one specimen is sent in for identification it is advisable to retain a duplicate specimen and to give the original and the duplicate the same number. The Botany Laboratory report will quote the collector's number for each specimen so that there is no doubt as to which specimen the name refers to.

3. *Drying of Specimens*—Specimens that are not fleshy and which will reach the Laboratory within two or three days can be placed between sheets of newspaper and then between a couple of sheets of cardboard and posted directly to the Department of Agriculture, Suva. The parcel should be marked **Plant Material for Identification.**

If the specimens are likely to take more than three days to reach Suva they should be partially, or fully-dried before despatch. This applies especially to plants with fleshy leaves : specimens have often been received in the last stages of decomposition and have been quite impossible to identify.

The simplest way to dry plant specimens is to place them between sheets of newspaper —the *Weekly News* or a similar magazine is very good for this purpose as the specimens can be placed between the pages which, being bound together, make a much tidier bundle than a lot of loose sheets of newspaper. The pages of this paper are a very convenient size too. As soon as the specimens have been placed between the newspaper a few books or a moderately heavy suitcase should be placed on top to press the specimens flat. For the first ten days the drying papers should be changed at least once, and preferably twice, a day. The damp papers can be dried in front of the fire or out in the sun, and then used again. At the end of the ten days a change of papers once a day suffices. The specimen is said to be dry when it becomes brittle—usually after about fourteen days. In very humid weather the collector may have to use his own discretion in deciding whether or not a specimen is dry as the leaf does not become brittle because of the dampness which is absorbed from the air.

The specimens can be placed between sheets of blotting paper if desired but, for a few specimens, newspaper can be considered to be just as satisfactory. The specimen should be arranged on the sheet so that as few leaves as possible overlap each other and so that the flowers are not too wrinkled and folded. A few leaves may be cut off tree specimens but a short portion of the stalk should be left to indicate their original position. Leaves that stick out over the edges of the sheet may be folded back. Figure 1 (*b*) shows the general lay-out of a specimen on a drying sheet. Fleshy fruits should be dried either whole or in halves or quarters (depending on their size) and it is usually desirable to dry these by placing them in the sun or near a stove. When they are dry they can be placed in an envelope and put with the rest of the specimen on the drying sheet.

Small specimens such as grasses may be folded to fit on to the drying sheet, if necessary, as it is desirable to have the whole plant on the one sheet.

4. *Packing of Specimens*—The labelled and numbered specimens should be placed between sheets of dry newspaper, one plant to a sheet, and the whole lot packed between two sheets of stiff cardboard and sent to the Department of Agriculture, Suva.

A note stating the information required, apart from the name of the plant, should be enclosed.

The parcel, as stated above, should be labelled **Plant Specimens for Identification.** If good specimens with flowers are sent in it will ensure prompt identification.

II. THE PREPARATION OF A PLANT COLLECTION.

1. *Type of specimen to be collected*—Tree, herb and grass specimens should be collected as described above. Fern specimens should consist of at least one mature frond with spores, and mosses and liver-worts should consist of a fairly large clump of the fully mature plant. Information regarding the collection of seaweeds, fungi, etc., will be supplied on request.

2. *Pressing and Drying of Specimens*—Specimens are usually put straight into a press, together with their field label, when they are collected (see Figure 1 *a*). A tin case called a vasculum is sometimes used (see Figure 1 *f*) and plants may be kept in this, provided the lid is kept closed, for several days. When a vasculum is used it is advisable to tie the field label on to the specimen so that, when several specimens are collected from different localities, the labels do not get mixed up.

Wire presses are used in the field by the Botany Laboratory staff because they are light and easy to handle. It is possible, however, to make a very satisfactory plant press from a few old pieces of wood, and this type of press, although fairly heavy, does just as good a job as the wire press. The drying and mounting sheets most commonly used are 17½ inches long and 11 inches wide and it is desirable that the press be slightly larger—18 x 12 inches is a suitable size. The press is made simply by nailing a few boards of a suitable size together with cross-pieces as shown in Figure

Figure 1—(a) A home-made plant press ; (b) Layout of a specimen on a drying sheet ; (c) A good tree specimen ; (d) A good grass specimen ; (e) A good herb specimen ; (f) Vasculum for carrying or temporarily storing plants ; (g) A mounted specimen showing arrangement of field and herbarium labels.

1 *a*. The cross-pieces protrude slightly over the edge of the boards and are grooved to hold the rope which is used to supply the pressure to the specimens. Strong cord fishing line is very satisfactory for this purpose.

FLORA OF FIJI.

Name .....
Family .....
Common name .....
Collector .....
Island or Province .....
Locality .....
Habitat ..... Altitude.....
Growth form..... Height.....
Flower .....
Fruit .....
Special notes.....
.....
.....
Economic uses.....
Date.....

Figure 2—The type of field label used in the Botany Laboratory.

Newspaper or blotting paper can be used as drying paper and the specimens are placed between the sheets in the press which is then tied tightly together with the cord. The specimens are changed twice daily for the first ten days and then once daily until they are judged dry, as described above. The arrangement of the specimen on the sheet has been described already.

Specimens will be found to retain their colour if heat is applied to speed up drying. When heat is used the specimens are placed in the press between the drying sheets and then between sheets of corrugated cardboard which allow the hot air to pass between the corrugations thus ensuring that each specimen is heated. A constant, fairly low, heat is the most satisfactory although it is desirable to "kill" the specimens quickly by applying a stronger heat in the first instance. A small kerosene wick stove turned low is quite useful for drying in the field but it must be watched all the time it is alight as the danger of fire is considerable. A stand is made to support the press or presses about eight inches above the top of the stove and the presses are placed on the stand so that the hot air can pass through the corrugations in the cardboard. First class specimens can be prepared in a fairly short time by this method which dispenses with the tedious job of changing the drying papers twice daily. Most fruits can be dried in the press but large, very fleshy fruits should be dried by placing them in envelopes on top of the presses where they get the hot air as it passes out of the corrugations in the cardboard.

A large electric drier, heated by light bulbs, is used in the Laboratory for drying specimens as, although it is slower than the kerosene stoves, it is very much safer. A biscuit tin with an electric light bulb in the bottom and the press sitting over the mouth makes quite a handy drier for one press-full of specimens.

The specimens are pronounced dry when the leaves become brittle. In this climate the specimens are found to absorb a small amount of water from the air once they are removed from the drier and they lose this brittle quality fairly quickly.

3. *The Mounting of Dried Specimens*—As soon as the specimens are removed from the drier or press they are mounted on sheets of white cartridge paper, the field and herbarium labels are attached, the identification of the specimen is checked and they are stored away in an appropriate box for reference purposes.

There are two methods of mounting both of which are quite neat. The specimen is arranged on the sheet in the most convenient position and the field label is attached to the top right hand corner and the herbarium label to the bottom left hand corner. If the fruits have been dried separately they are placed in an envelope and, usually, attached to the sheet just above the herbarium label. Both labels and the envelope have the number of the specimen on them. The first method of mounting merely consists of pasting slips of paper, ¼ to 1/5 inch wide, across the stem at intervals and, if necessary, across some of the leaves so as to ensure that the specimen is firmly attached to the sheet. The second method is neater although it takes a little longer to carry out. Slits are made in the mounting sheet and the strips of paper are pushed through them on each side of the stem, pulled tight over the stem and glued down on the back of the mounting sheet. Every attempt should be made to secure the specimen to the mounting sheet as tightly as possible with as few strips of paper as possible.

Figure 1 (*g*) shows a mounted specimen.

4. *Preservation of Specimens*—As soon as the specimens are mounted and identified they should be stored in a suitable box. In the Herbarium all the specimens are stored in wooden boxes which have the top and front hinged for ease of access. The boxes are arranged in botanical order and each specimen is placed in the appropriate box where it can be found very quickly when it is required for reference purposes.

There are several methods of preserving specimens from insect and fungal attack but some of these involve the use of very dangerous poisons. The boxes in the Herbarium are sprayed inside with D.D.T. once a month and a liberal supply of napthalene flakes is kept in each box. This has been found to be quite satisfactory provided the specimens are regularly checked. It is quite a good idea to place the mounted specimens in a warm place, (the electric drier is used in the Laboratory), about once every six weeks for an hour or so to dry them off, and at the same time to discourage the growth of moulds. The Herbarium is also regularly sprayed out with D.D.T. Provided specimens are checked at regular intervals the damage caused by insect or fungal attack is not serious.

III. CONCLUSION.

It is hoped that this note will be of assistance to those who wish to have plants identified by the Botany Laboratory staff. The three most important points to remember are :—

1. *Always collect plant specimens with flowers.*
2. *Pack them flat between sheets of newspaper or blotting paper.*
3. *Partially or fully dry specimens with fleshy leaves and fruit. It is advisable to at least partially dry any specimen which may take more than three days to reach the Laboratory.*

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HORTICULTURE . . .

TREES—USEFUL AND ORNAMENTAL

BY C. WALKER

During the year 1953, *and particularly in connexion with the Coronation of Her Majesty Queen Elizabeth in May and with the Royal visit in December, special efforts were made to meet the demand for amenity plantings along roadsides and in public gardens. Large numbers of trees and shrubs were also supplied to committees, institutions and private persons interested in the general community effort to beautify the roads and public grounds in various parts of the Colony.*

ROADSIDE PLANTING

King's Road.—With the completion of road formation and tar sealing works, it was possible to put into effect long deferred plans for tree planting along that part of the King's Road which carries the heaviest traffic in the Colony both of tourists and local travellers.

As a start it was decided to arrange for the planting and care of a variety of trees in suitable sites on both sides of the road between Suva and Naduruloulou, five miles beyond the town of Nausori.

The supervision of this work was undertaken by the Weed Control Officer who was currently engaged on the eradication of noxious weeds in the locality and in collaboration with the Curator of the Plant Introduction and Quarantine Station, Naduruloulou, where most of the plants were propagated. The co-operation of the Road Superintendent of the Public Works Department ensured that sites chosen should not interfere with visibility, power and telephone poles or with foreseeable and prospective road works.

The procedure has also involved the sharing of responsibility for the future care of the trees by enlisting the active interest of residents along the road. Great interest has been shown by a large number of people which indicates that there will be little damage to or interference with the growing trees.

It was considered desirable not to attempt continuous, ribbon planting but rather to rely on discontinuous or group planting so as to establish the trees in strategic sites from the scenic and care-taking point of view. Later further plantings will proceed in both directions from these sites.

In this way during November–December a total of 197 trees were planted, 65 persons collaborating by agreeing to care for one or more plants. The species so far established are:—

Pink Cassia (*Cassia grandis*)	41	(28 sites)
Pink and White Cassia (*C. nodosa*)	6	(5 „)
Golden Flamboyant (*Peltophorum inerme*)	13	(7 „)
Timor Shower (*C. multijuga*)	18	(12 „)
Yellow Cassia (*C. laevigata*)	13	(9 „)
Flamboyant (*Delonix regia*)	25	(19 „)
Rose of Venezuela (*Brownea coccinea*)	32	(10 „)
Hybrid Dwarf Coconut (*Cocos nucifera*)	3	(1 „)
Jacaranda (*Jacaranda mimosaefolia*)	4	(3 „)
Breadfruit (*Artocarpus incisus*)	35	(6 „)
Tamarind (*Tamarindus indica*)	1	(1 „)
Honolulu Cassia (*C. bakeriana*)	3	(1 „)
Palm (*Pritchardia pacifica*)	3	(1 „)

TREES ISSUED—1953—

(*a*) SUVA CITY COUNCIL—Total, 193—

Cassia grandis	31
„ *nodosa*	20
„ *fistula*	6
Pterocarpus indicus	14
Ravenala madagascariensis	7
Coffea arabica	10
Delonix regia	15
Gmelina arborea	5
Bauhinia spp.	6
Pithecolobium Saman	5
Cocos nucifera	74
Cassia floribunda	15
Maniltoa	1
Peltophorum inerme	2

(*b*) PARKS AND GARDENS—

Cassia nodosa	2
„ *bakeriana*	2
„ *grandis*	10
Delonix regia	5
Gmelina arborea	10
Pithecolobium Saman	5

(*c*) PRIVATE AND INDIVIDUALS—

Lagerstroemia Flos-reginae	19	
Caesalpinia spp.	16	
Cassia fistula	31	
„ *bakeriana*	25	
„ *nodosa*	38	
„ *grandis*	21	
„ *laevigata*	4	
„ *multijuga*	5	
Coffea arabica	25	
Codiaeum spp.	14	
Theobroma cacao	24	
Delonix regia	20	
Carica papaya	22	
Bauhinia spp.	16	
Peltophorum inerme	10	
Cinnamomum zeylanicum	6	
Anacardium occidentale	19	
Anonamuricata	6	
„ *squamosa*	2	
Bauhinia purpurea	1	
Swietenia spp.	15	
Tectona grandis	1	
Persea americana	23	
Gliricidia maculata	150	cuttings
Gardenia spp.	10	
Lansium domesticum	2	
Passiflora edulis	4	
Areca catechu	2	
Mangifera indica	6	
Citrus decumana	1	
Punica granatum	2	
Agathis vitiensis	2	
Aleuritis montana	3	
Artocarpus integrifolia	6	
Brownea spp.	2	
Oreodoxa regia	3	
Spathodea campanulata	1	
Artocarpus incisa	2	
Melia azedarach	6	
Maniltoa	1	
Podocarpus vitiensis	1	
Hibiscus rosa—sinensis	24	cuttings
Cocos nucifera	304	
Musa sapientum	20	suckers
„ *paradisica*	2	„
Vanilla planifolia	28	cuttings
Piper nigrum	6	„

(*d*) INSTITUTIONS—

Gmelina arborea	61	
Gliricidia maculata	150	cuttings
Areca catechu	10	
Caesalpinea spp.	10	
Lagerstroemia Flos-reginae	12	
Swietenia spp.	11	
Codiaeum spp.	19	
Canna vars.	380	
Tectona grandis	7	
Cassia grandis	13	
Persea americana	2	
Anacardium occidentale	1	
Cinnamomum zeylanicum	1	
Cassia bakeriana	9	
„ *fistula*	7	
„ *nodosa*	13	
„ *laevigata*	5	
Bauhinia spp.	8	
Veitchia storckii	4	
Coffea arabica	1	
Theobroma cacao	3	
Brownea spp.	1	
Bauhinia monandra	4	
Allamanda	140	cuttings
Ixora vars.	13	
Baringtonia speciosa	2	
Calophyllum inophyllum	2	
Oreodoxa regia	3	
Cocos nucifera	18	
Bougainvillea	30	cuttings
Brynea nivosa	2	
Tamarindus indica	5	
Euphorbia pulcherrima	2	

Adi Cakobau School Sawani, 1953—

Pimenta acris	2	
Couroupita	1	
Cycas rumphii	1	
Macademia	1	
Curcuma domestica	..	
Aleurites mollucana	1	
Zingiber Officinale	50	
Brownea coccinea	4	
Eugenia caryophyllata	..	
Cassia laevigata	1	
Cinnamomum camphora	..	
Eugenia michelii	1	
Eranthemum insularum	1	
Codaeum spp.	60	
Peltophorum inerme	1	
Lagerstroemia-Flos-reginae	3	
Erythrina fusca	5	
Kleinhovia hospita	..	
Ixora.	1	
Jacaranda mimosaefolia	4	
Bauhinia galpini	1	
Agave sisalana	3	
Broussonetib papyrifera	..	
Boehmeria nivea	6	roots
Musa textillis	1	
Maranta arundinacea	20	
Tacca pinnatifida	..	
Canna edulis	..	
Tecoma stans	50	

LEVUKA TOTAL 200 TREES—

Cassia nodosa	10	
Bauhinia spp.	40	
Agathis vitiensis	5	
Palms	30	
Albizzia falcata	20	
C. grandis	70	
Brownea coccinea	5	
Podocarpus vitiensis	5	
Delonix regia	5	
Cassia fistula	10	

DISTRICT OFFICER SOUTHERN (NAUSORI) Total 150—

Delonix regia	40	
Bauhinia spp.	30	
Albizzia falcata	5	
Cassia grandis	60	
Gmelina arborea	15	

NADROGA COMMITTEE—85 total—

Pithecolobium Saman	50	
Oreodoxa	35	

MARKETING . . .

THE HARVESTING, HANDLING AND PACKING OF PINEAPPLES FOR EXPORT

The pineapple is very susceptible to bruising, consequently the harvesting, handling and packing must be conducted in a manner designed to prevent injury.

Bruised areas on the fruit permit the entry of rot-producing organisms which will rapidly render the fruit unfit for consumption ; superficial bruises are not easy to detect when the fruit is being packed and then often only by the slight exudation of juice at the place of injury.

It is therefore essential that as much care as possible should be taken on preparatory work and that liberal use should be made of wood wool particularly in the case of fruit intended for overseas markets where wastage is comparatively high.

The following procedure is recommended in order to market fruit in a sound, attractive and palatable condition :—

A. Type of Fruit—

The following types should be rejected—

(i) Fruit showing any leakage of juice either from brusises, growth cracks or other causes.

(ii) Fruit visibly affected by sunburn, yeasty rot, black speck or bruises.

(iii) Fruit with more than two tops.

(iv) Fruit with knobs or slips on the base of the fruit.

(v) Fruit without tops or with aborted, dwarfed or deformed tops.

(vi) Malformed or crippled fruit.

(vii) Fruit whose stalks have been partly or wholly broken before maturity.

B. Maturity—

The state of maturity at which fruit should be picked is dependant upon its ultimate destination and the time that will be spent in transit. Fruit of the Smooth Cayenne or Queen varieties should be harvested before the yellow skin colour is marked as they do not carry so well as the Ripley pineapple.

Queen pineapple showing the stem trimmed back to 1 inch from the base.

C. Handling—

(i) Fruit must not be snapped but should be cut from the plant with a sharp knife leaving 1 inch stem, whilst outsized tops should be trimmed back to not less than 2 inches from the top.

(ii) Fruit should be carefully handled from the time of harvesting to the time of shipment, every precaution being taken to avoid bruising : The practice of placing the fruit in stacks should be avoided as this practice is conducive to bruising, nor should it be loosely packed in sacks or cases when being conveyed from the field.

(iii) Fruit which has been harvested should be protected from the direct rays of the sun.

(iv) Wood wool should be used between the fruit as much as possible during handling operations.

(v) It is essential that all fruit should be brushed before packing to remove mealy bug, a defect common among Fijian pineapples.

D. Packing—

(i) The fruit should first be graded so that the contents of each case will be uniform in size and colour.

(ii) All packs should have the fruit placed across the case with the butts against the side of the case, wood wool being used on the top and bottom of the case, between each fruit and at the base of each fruit where it touches the case. Sufficient space should be left above the top layer of fruit to allow for a protective layer of packing material so that a firm pack will result when the lid is secured.

(iii) The following tables of packing counts will be found satisfactory, the sizes of fruit shown being those recommended as suitable for shipment—

Quantity of fruit per case	*Approximate diameter*	*Number of layers*	*Quantity of fruit in each layer*
15	4⅜"—5"	3	5 x 5 x 5
18	4½"—4⅝"	3	6 x 6 x 6
21	4⅜"—4½"	3	7 x 7 x 7

First, second and third layers of fruit 4½ inches in diameter packed six to the layer.

Pineapples consigned to destinations outside Fiji must comply with the Fruit Export and Marketing Regulations, the following being briefly some of the relevant conditions—

(i) Fruit must be packed in cases which have not previously been used for any other purpose, each case being branded with the consignor's shipping marks.

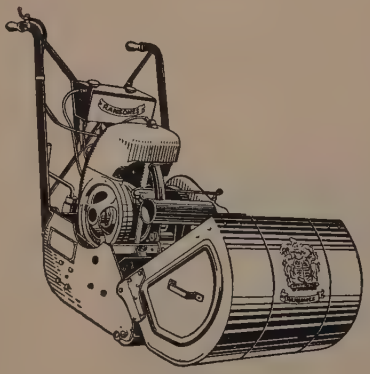
(ii) Fruit must be graded to the satisfaction of the Director of Agriculture or Inspector of Produce, any labour required in connexion with such work being provided by the exporter.

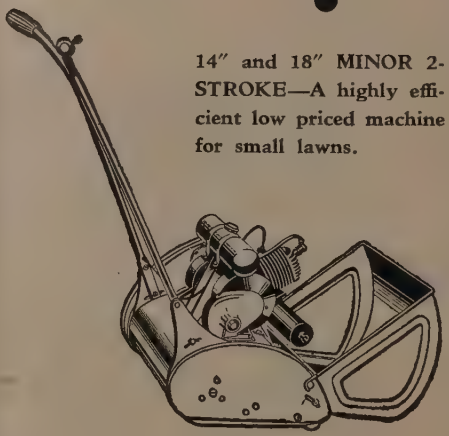
(iii) An Inspector may reject any consignment which is considered to contain an undue proportion of fruit unsuitable for shipment : the Director of Agriculture or the Inspector of Produce may at their discretion refuse to the exporter permission to repack the fruit and again present it for shipment.

(iv) A certificate signed by the exporter should accompany each consignment stating that the fruit or the plant on which it was grown, has been treated in accordance with the provisions of any regulations made under the Noxious Weeds and Diseases of Plants Ordinance.

(v) Exporters should give the Inspector of Produce prior notice of their intention to export pineapples and obtain instructions on the delivery of their stocks for fumigation.

MOTOR MOWERS
by RANSOMES





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PLANT NUTRITION . . .

BAT GUANO AS A FERTILIZER

BY N. G. CASSIDY

From time to time samples of bat guano are received for the assessment of their value as a fertiliser.

The guano is usually dark brown to reddish dark brown in colour, soft and moist, and showing glistening surfaces.

The following table shows the analysis of four different samples as well as the average value for each constituent :—

	Analysis of air-dry material (%).		
Original moisture (%).	*Nitrogen*	*Phosphoric acid.*	*Place of Origin.*
63	7.7	1.9	Cave at Tau.
34	5.4	1.9	Island, Viti Levu Bay.
67	7.0	3.8	Cave near Navua.
60	2.5	5.1	Island (unknown).
56	5.6	3.2	Average.

It is noticeable that the average moisture content is high, in fact over 50 per cent. This is the main characteristic of bat guano as obtained in Fiji. In order to make a useful fertilizer it is necessary to dry the material, in which case a fertilizer with about 6 per cent nitrogen and 3 per cent phosphoric acid can be expected. Since the constituents are not very water-soluble, even the dried fertilizer needs to be applied at a rate of about half a ton to the acre. If the wet material is used it would need to be applied at 3 times this rate.

As a rough guide to values, bat guano may be taken as worth not more than one-fifth of the average cost of sulphate of ammonia and superphosphate. Thus with sulphate of ammonia at £35 per ton and superphosphate at £20 per ton, average bat guano would be worth about £5 per ton in the wet condition. When thoroughly air-dried it would be worth about twice this amount.

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SOIL SURVEY . . .

AN INTRODUCTION TO THE SOIL SURVEY OF FIJI

BY I. T. TWYFORD

At the end of the first three years of the Soil Survey, it seems appropriate to review its history and its progress to date, and also to try to explain the uses of the survey, in other words what the public may reasonably hope to get out of it.

A soil survey is now in being in most progressive countries of the world, for it is being more and more realised that to obtain much improvement in the efficiency of agriculture, it is absolutely essential to have information on the qualities and capabilities of the soil, on which after all, all agriculture is based.

The Fiji Government soon realised this and supported the idea of a soil survey for many years.

History—Until 1939 only limited local soil information had been obtained[1, 2] by the Chemistry Section of the Department of Agriculture, and the possibility of a regional soil survey was not considered until the then Senior Chemist, W. J. Blackie, proposed a scheme by which the whole of Fiji would be covered by normal departmental staff. However, the advent of the war prevented this scheme from being implemented, and between 1939 and 1945 only a few areas were investigated in an *ad hoc* manner.[3-6]

In 1944 the question arose again when Professor C. Y. Shephard[7] recommended that a soil survey be carried out, employing a team from the Imperial College of Tropical Agriculture in Trinidad with the chemical work to be done by personnel of the Fiji Department of Agriculture. He also recommended that a permanent soil chemist be appointed to the Department. Paterson and Dodds, however, in 1945[8], disagreed with Shephard and considered a soil survey at that time to be " too comprehensive and academic to be of immediate practical importance in agricultural rationalization ". However, they agreed that a soil chemist should be appointed to deal with specific soil problems as they arose.

The Government in 1946 decided after consideration of these two reports to proceed with the appointment of a Soil Chemist who would be trained sufficiently to do field work for a soil survey of the Colony.

L. E. Smythe was appointed for this work in 1947, and until 1949 he was actively engaged in carrying out a soil survey of some provinces, notably Rewa and Nadroga-Navosa. Soil notes appeared from this worker and also from Blackie up till 1949, on various aspects of soil survey work in Fiji and describing initial results.[9-17] However he was hampered by lack of laboratory staff and facilities, and so the full value of his work was never attained.

The Department then applied (1949) to the New Zealand Department of Scientific and Industrial Research for a soil survey field team. Dr. L. I. Grange, then Director of the Soil Bureau of D.S.I.R., New Zealand, visited Fiji and made a preliminary estimate of the time, area and problems involved, and decided in favour of the proposal.

The problem of base maps then arose and this was not solved until the aerial survey was begun in 1951. With air coverage of half the main islands completed, a team consisting of Messrs. J. P. Fox and I. L. Baumgart arrived at the beginning of the cool season in 1952, and mapped the Sigatoka, Nadroga, Nadi, Lautoka, Ba and Tavua areas on a reconnaissance scale of 1" to 1 mile, using the new aerial photographs.

Meanwhile a soil survey chemist was appointed from England on contract for three years. The analytical work of the soil

survey was thus started simultaneously with the field work, and a good field-laboratory liaison has been maintained ever since.

Fox in the 1953 dry season completed the mapping of Viti Levu, and the analytical work was completed by the beginning of 1955. During 1954, no pedologist was available for mapping.

A preliminary field report has now been written by Fox on the Soil Survey of Viti Levu. The chemical work has yet to be added to this.

In February of this year, Mr. A. C. S. Wright of the New Zealand Soil Bureau arrived for the mapping of Vanua Levu and Taveuni. He had just returned from secondment to British Honduras where he had carried out a soil survey.

Finally the appointment of the soil survey chemist has been made permanent, so that any detailed surveying will be possible within the Department, and in order to help with fertility problems.

Results to date—The whole of Viti Levu has been mapped on the reconnaissance scale of 1 inch to 1 mile, using aerial photographs wherever possible and American army or N.L.C. maps where aerial photographs were lacking.

It is not the purpose of this article to describe the soils of Fiji, a full account will be available fairly soon. Nevertheless it is perhaps timely to present a few broad aspects of their properties which have emerged in the course of the soil survey.

Fox's report and the chemical work have shown that the soils may be divided quite distinctly on a climatic, geological and topographic basis, in accordance with pedological theory.

The three climatic zones in Viti Levu, the wet, intermediate and dry have quite distinct soil types, with extremes in the wet and dry zones and intermediate types in Nadroga and Ra. The high land of the interior of the island also has its own range of soils.

In general, as the climate gets wetter weathering of rock and leaching of the resultant soil take place at an increasing rate. This means that on a flat site soils derived from the same rock tend to be deeper, more acid and infertile in the wet zone, than in the intermediate or dry.

High altitudes in Viti Levu are usually associated with higher rainfall than in the corresponding low altitude areas, but of course here a complicating factor is the lower prevailing temperature at high altitudes. At Nadarivatu for example, the temperature sometimes drops to a little above freezing point and this lowering of temperature tends to decrease the rate of weathering. However it is likely that the high rainfall more than makes up for this.

The climatic factor in soil formation is seen clearly in association with the natural vegetation of the zones. That of the wet zone is typically heavy rain forest, of the intermediate zone is savannah-like country with some trees and some grass, and that of the dry zone is pure grasses, with trees only on particularly wet places, or on limestone.

This is reflected in the amount and type of organic matter contained in the various soils and the organic matter gives rise to greater or less amounts of acid which are used in leaching the soil. The greater amounts of organic matter in soils under virgin forest give rise to larger amounts of acid for leaching and this exaggerates the already high leaching due to the rainfall alone.

Until 1952, the geology of Viti Levu was little known. Various sketch maps had been drawn by geologists visiting the Colony for one reason or another but these were very different and it was difficult to judge the relative accuracy of these attempts. A fairly recent map by Professor Shackleton now of Manchester University was made available to the soil survey and was used to a considerable extent during field work. In 1952, however, the Colony's own Geological Survey started operations and since then the closest co-operation has been maintained between the two surveys. Regional geological mapping has been confined, so far, to S.W. Viti Levu, some parts of the Sabeto range, parts of Navosa and parts of Tailevu and Ra. However in other areas the Geological Survey has always under-

taken to identify rock samples submitted by the Soil Survey. It soon became clear that there is a close relation between solid geology and soil types, particularly in the dry and intermediate climatic zones.

The range of rocks in Viti Levu is not wide. The vast majority are of basic or intermediate composition (i.e. low in silica) igneous rocks, and basic or intermediate tuffs (roughly speaking, layers of volcanic ash or dust). There are very few acid rocks though some occurrences of rhyolite and rhyolitic tuff are known. Thus most of the soils are derived from basalts, andesites, basaltic and andesitic agglomerates, and various basic tuffs. In addition there are soils from marls (tuffs containing a fair proportion of calcium carbonate, i.e. lime) and a few from limestones, as well as one or two from rhyolitic tuff as mentioned above.

In the dry and intermediate climatic zones, the geology seems to play a very important part in the soil type formed. Thus soils from basalts, andesites and tuffs although with some features in common, are nevertheless quite distinct and unmistakeable. In the wet zone on the other hand, weathering and leaching are so severe that parent material has rather less influence on the final product, unless it has some special features, such as very high content of calcium carbonate (lime) which resist for a much longer time the effects of heavy continuous rainfall.

Summarising the above ideas on climate and geology in soil formation and putting the idea in a slightly different way, it is found that black and brown soils are often more fertile than red ones. In the dry zone, there are black, brown and red soils with a fair proportion of the first two. In the intermediate zone there are more areas of red soil and in the wet zone it is only where the rocks have a high content of calcium carbonate or the soil is in constant motion that any black and brown soils are found at all.

The influence of topography has also been found to be of the first importance. Where soils are stable, i.e. on flat areas, weathering has gone to a great depth and in the Ba province this has resulted in some places in the formation of laterite, often showing weathering to a depth of 40 feet. These laterite soils stand out as flat topped hills in the surrounding fairly low-lying plains. They are considered to be relics of old plains which have all but eroded away. Fertility in such soils is, of course, extremely low.

On land where there is an appreciable slope, soil development is never allowed to go as far as this, and the soils are not so deep and infertile. Where soils are continually in motion as on steep slopes they tend to be shallow, fertile and often of dark colour.

The most important soils are the alluvial soils. These are soils which have been deposited by river action or sometimes by the sea. Soils in the river valleys are often the most fertile of each climatic region. Further, their usefulness is greatly increased by the fact that they are flat and therefore easy to farm.

In Fiji, alluvial soils tend to have a fairly heavy texture (usually clay loam) with very sandy banks immediately beside the river. The level often falls off away from the river and poorly drained soils are found usually just below the foothills. The alluvium which formed these soils is derived in the main from basic rocks, and as it begins to decompose, it releases large quantities of plant nutrients, which ensure the continued fertility of the soils.

In the dry and intermediate zones the alluvial soils are very fertile and are fairly intensively used for vegetable crops or sugar. In the wet zone they are more leached and not so fertile. More of them are poorly drained and so they are suitable for rice growing.

A few peats have been encountered : these are highly acid and infertile.

The chemical work of the soil survey has shown that acidity and lack of phosphorus are probably the greatest soil problems to be encountered in Viti Levu. So far as is known potash is fairly well supplied, at least in virgin soils. Organic matter is rather higher in virgin samples than was originally suspected. This implies that there is some fertility in even the most leached and weathered soils, and is further borne out by

the fact that virgin soils, for example in the wet zone, support thick bush. But it is bad agricultural practice to cash in on this, unless there is an abundance of such land so that shifting cultivation can be practised. Otherwise the destruction of organic matter is so fast under ordinary clean cultivation conditions that the soil is soon reduced to an infertile mass of clay, which is an easy prey to erosion. This, however, is a problem rather for the future, when land pressure is great.

Soil Survey Method—Soil surveying consists in the examination of soil profiles all over the country, (a soil profile is that vertical face of soil exposed when a hole is dug in the ground from the surface down to the bedrock or other soil parent material) collecting similar ones together, and defining these as a soil type. Often, if the individual areas of soil types are small, and two or more types in a larger area are related, they are mapped together as a soil association or a soil complex.

All the soil types or associations are plotted on the base map so that the final product shows all the areas of all soil types and covers the whole country.

In addition to this, the soil surveyor makes notes of the climate, geology, topography, vegetation, drainage, soil animals and any other appropriate ecological features of each soil type, so that in effect a soil survey is also a good basis for an ecological survey. However these ecological data are primarily collected to discover the origin of the various soils, and the processes which are taking place on them and in them.

Soil samples are then taken from representative soil profiles and analysed for plant nutrients, and other chemical data collected to help in classifying the soil types.

Finally, on the basis of the above work, appropriate manurial or variety trials are carried out to make a preliminary investigation of soil fertility problems.

Uses of the soil survey—

1. Apart from all other consideratons, in a country like Fiji, which is only partly explored, the soil survey which involves visiting all parts of the Colony, can give new geographical information and a guide as to access of various areas.
2. The fertility status of all parts of the Colony is studied. In addition, fertility trends in time are examined. Some soils decrease in fertility as time goes by, others remain static, and others even increase. This knowledge is of the greatest value to farmers and others desirous of estimating the worth of a farming venture.
3. The soil survey is the only rational basis for efficient land utilisation. In a country like Fiji with a rapidly expanding population, it is obvious that the efficiency with which the land is used is of the greatest importance. For instance, it may be that from this point of view, a particular piece of land is growing an unsuitable crop.

   The soil survey is in the best position to give a guide as to what is roughly the most efficient use for all the Colony's land and to ensure that development takes place along the right lines, having regard to economic as well as strictly scientific conditions, of course.

   There are three cases in which the soil survey provides essential information for improving the efficiency of land utilisation. Firstly in the developments of new areas the soil survey can say where the most suitable places are situated, or what agricultural value any proposed land development scheme has, and also what are the right lines for such development to follow. This has already been done in a few cases in Viti Levu and Taveuni. Secondly, it can give information on the value of reclamation of new land, such as mangrove swamps and peats. In a country growing progressively shorter of good agricultural land, it may be necessary to reclaim such marginal areas. Already in Fiji a preliminary investigation has been made on the reclamation of the Navua plains for rice growing. The soil survey has been able to provide basic information for this scheme.[18]

Thirdy, as outlined above the soil survey is able to show to a certain extent whether present cultivation of particular areas of land is efficient. It may be, for example, that rice monoculture or rice and pasture combinations have reduced the fertility or spoiled the physical properties of the soil. This has been found in a soil survey in certain areas of the Dreketi Valley, Vanua Levu.

4. A pressing problem in Fiji is soil erosion. In the course of the soil survey it is necessary to take both erodibility and the actual amount of erosion into account. This will be useful in the soil conservation programme of the Colony, since from the survey it is possible to forecast where erosion is likely to occur after the cultivation of new land, and how bad it will be.

5. In connection with the last four points, the soil survey enables an intelligent estimate to be made of the value of land. This is useful, of course, for the purpose of arriving at fair rentals on leasehold property or for any land taxation system that may be projected. Further, it will be possible to give a critical evaluation of the areas to be set aside as Fijian Reserves and even, perhaps, to help in this work.

6. The soil fertility experiments that are carried out by the Department of Agriculture, the Colonial Sugar Refining Co. Ltd., and others are now able to be placed on a rational basis. Hitherto it has been merely guesswork in trying to compare results of field experiments on different areas. Further, in the past, much work has been duplicated needlessly because of a lack of soil survey information.

A soil survey groups together soil types which behave in the same manner. Thus if a certain response is obtained in a field experiment in one area, then it should be possible to get the same result on other areas of the same soil type, and to a lesser extent on similar but somewhat different soil types. For instance, the soil survey has shown that the soils of Navua flats and certain of the Rewa flats are of the same soil type, and so it is possible to apply results of field experiments or efficient methods of farming *en bloc* from one area to the other. Moreover it would not be necessary to embark on a plan of extensive field experimentation in both areas ; it is only necessary to do it on one area and perhaps just a few check experiments on the other.

In connexion with this, it becomes clear what is the exact value of the experimental stations. Ideally, an experimental station should be situated in an area whose soil is typical of a fairly large district, so that the results of field experiments, which are usually most efficiently carried out on a station, can be applied to the area of which the station is typical. In this case, when choosing the site for an experimental station the soil survey should be consulted. When, however, as is the case in Fiji, the stations are established before the soil survey begins, the soil survey can only evaluate their usefulness. Thus it is now known that the station at Dobuilevu, Ra, is typical of much of Ra province, the sequence of red and black soils found on the station is a sample of all the N.E. area which is covered with tuff soils.

The Sigatoka station consists of two parts, the valley flats and the rolling hills. The valley flats are typical of all intermediate zone alluvial soils and the rolling country is typical of much of the fairly low lying (up to say 350′) parts of Nadroga. Thus results involving the soil factor on this station are applicable over a wide area.

The Koronivia station is, however, slightly different. It consists of two parts, the flats and some high terraces, now broken down into flat topped hills. The Rewa flats are composed of soils, as mentioned above, typical of the Navua plains, as well as the Rewa plains and so are of great useful-

ness. Methods of farming worked out on the Station or results of trials are applicable as they stand to the flats of both the Rewa and the Navua areas, which comprise a considerable proportion of the agricultural land of the wet zone.

The hills on the Koronivia station are covered, however, with a highly weathered and leached siliceous soil (from acid rocks) which occurs only over a small area (2.5 sq. miles). This soil type is quite different from the typical hill soils of the wet zone, which are red clays from basic rocks. Thus it is unlikely that results obtained on the hills of Koronivia, involving this soil, can be easily applied to the majority of the hilly country of the wet zone.

At Naduruloulou the hilly land is very typical of the wet zone soils and so experiments particularly with tree crops such as cacao, can be usefully sited on the station's high ground. Similarly, the flats are typical of the Rewa valley.

7. The Colony's roading programme is also affected by the soil survey. Where roads are to be planned for opening up hitherto inaccessible areas, it is essential that they should take the most agriculturally useful route consistent with engineering feasibility. Happily the two latter criteria often fit. In the present case, the soil survey has been consulted and the projected roads should finally be sited in suitable places.

8. The soil survey may help with other engineering problems. Examples are the siting of aerodromes, the quality of soil-cement mixtures, and the use of clay in building houses. In the case of Nadi airport, the New Zeaalnd Soil Bureau sent a soil mechanics expert to advise on the packing and other qualities of the Nadi clay. During the present soil survey the possibility of making bricks from local clays either kiln dried or sun dried, has been examined in conjunction with the Public Works Department.

9. The areas most suitable for forestry are very important from two aspects, that of the Colony's timber supply and that of the prevention and checking of erosion. The soil survey is in a position to advise on the areas best relegated to permanent afforestation. Liaison has been maintained with the Forestry Department.

10. Finally, there is the question of disease. Animal and human diseases are often related to nutritional deficiences. Such deficiencies can often be predicted from soil survey data. For instance, soils derived from leached siliceous sands often have certain trace-element deficiencies and these may cause diseases in plants, animals and even people. Moreover when a nutritional deficiency disease is suspected in an area, the soil survey can often tell whether or not such a deficiency is feasible, and if so, what it is likely to be. Recently a copper deficiency disease was suspected in northern Viti Levu. Soil survey information indicated that this was unlikely and a subsequent investigation by the Department of Agriculture showed that this was in fact the case.

Conclusions—The soil survey provides basic information for many aspects of agricultural development. It also gives a useful background from which to assess various other projects.

However, it should be emphasised that the soil survey does not give a complete answer to any particular problem. The present survey has been carried out on a reconnaissance scale only and for local areas it is usually necessary to do further work for particular projects. Thus, if a settlement scheme is proposed in any part of the Colony a detailed soil survey would give much information on how to break up the area into suitable units for holdings of such a size that a reasonable standard of life could be expected by the tenants. On the other hand, the present soil survey would only show how suitable the total area is for development and roughly what line it should take.

As far as fertility problems go, the soil survey shows where results of experiments can be validly applied and where they cannot. In addition, it gives a rough idea of what the results are likely to be. Thus it opens up useful lines of investigation. In fact, it defines the problems, and soil fertility work can then be carried out on a rational basis.

It is fortunate that unlike many countries, Fiji has soil survey information available at an early stage of her development. Thus it should be possible to proceed along the right lines avoiding many pitfalls which other countries have encountered.

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New Agricultural Publication . . .

THE GRASSES OF FIJI

by J. W. PARHAM, B.Sc.

A Bulletin describing the grasses so far recorded in Fiji is to be published shortly and will be on sale at the Department of Agriculture and at the Government Printing Office.

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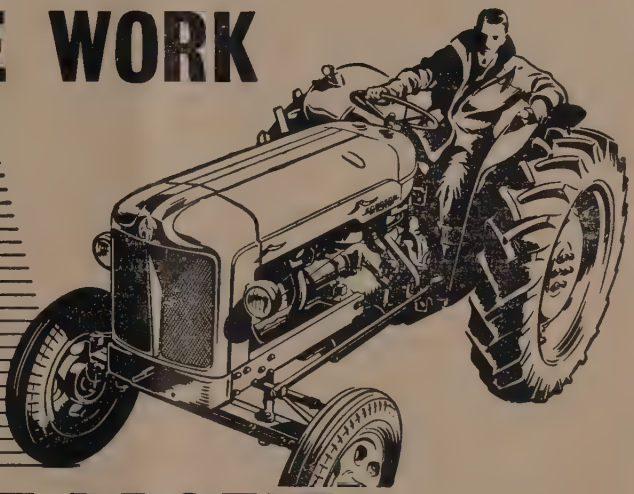

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SOIL CONSERVATION . . .

BIOLOGICAL SOIL CONSERVATION AND FARM PLANNING IN SOUTH AFRICA*

At the initial stage of the soil conservation campaign in South Africa, soil erosion was considered to be a purely mechanical problem, but within a comparativey short period one aspect after the other has been added to the former simple conception until to-day we realise that erosion is the most complicated result of man's interference with the natural balance of certain interacting natural factors, of which soil moisture, vegetation, run-off water, microganisms and soil structure are the most important.

At that time the Government acquired heavy soil-removal machinery for undertaking the construction of so-called major works but, unfortunately this only served to perpetuate the existing misconception of soil conservation in that it stressed the mechanical rather than the biologcal aspect of the problem.

This interpretation, viz. that soil conservation is a purely mechanical problem, may be compared with a similar misconception, viz. that surgical operations are the principal solution for most human ailments, whereas operation would in many cases not have been necessary, if the patients had eaten sound and wholesome food, their bodies had received the needed rest without being exposed to unfavourable conditions or being overtaxed, i.e. if the patient had followed a healthy way of life. As with the human body, nature, if allowed to operate correctly, is our best ally against soil erosion. Keep the soil in a fertile condition by supplying the necessary plant nutrients; keep it sound by rotational cropping and use sound seed, protect it against wind and water, and major operations will not be necessary.

There are unfortunately many cases where the necessary precautionary measures for avoiding soil operations have not been taken, and in such cases it is necessary to carry out mechanical operations. Even in such cases, however, we should aim at only enabling nature to carry out her healing work. Filling up a donga without removing the underlying causes and without seeing to it that the vegetation in and around the donga is stabilised, presents a reclamation as temporary as the healing of a person who as a result of a wrong way of living, takes narcotics but fails to remove the real cause.

In spite of numerous examples in the Union of South Africa of eroded land which has been fully restored by biological methods of control, there are still many people who believe the first and most important step in the campaign for the conservation of our natural resources to be a mechanical operation.

This view cannot be condemned too strongly, and the sooner it is abandoned, the sooner the final aim contemplated by the Soil Conservation Act will be realised, namely the development of the agricultural potential to its maximum capacity by judicious farm planning.

It is, however, self-evident that it will be a long time before every farm in the Union will have been planned in accordance with the Soil Conservation Act, and in the meantime much valuable soil may be lost. Nature is, however, at the call of everybody, and if her assistance is enlisted by the application of judicious crop and pasture rotation, the most important principles of farm planning will have been observed.

It must, however, not be inferred that mechanical operations are not occasionally necessary, but, they should not be performed at the expense of or without, biological control. In fact there are cases where the owner has already received his farm planning scheme but being at present unable to have the mechancial operations

such as wire fences and contour banks, etc., erected does nothing to carry out the other directions, because of a mistaken conception in regard to soil, veld and water conservation. Before giving consideration to machinery, banks, dongas, etc., the farmer should first pay attention to better farming systems and practices. The rapid increase in population in the Union of South Africa and the limited arable area, necessitate the development of the agricultural potential of the Union to its maximum. For that reason it is so necessary that every farm should be planned as soon as possible, and that conservation farming be applied. Not only will the income of the farmer be stabilised thereby, but more and cheaper food will be produced without any deterioration.

The matter is, however, urgent, and we must utilise the resources at our disposal. Let us therefore in the meantime manage our farms correctly rather than wait for machinery for filling up eroded places. This is not only cheaper, but also of a more permanent nature and in addition, will lead to an earlier realisation of the aim set by both the Department and the farmers.

The good rains of the past two years have given nature an opportunity of making up leeway which resulted from faulty farming practices. If, therefore, the biological method of soil conservation could be s ressed more, so that the advantage gained during the prosperous years can be judiciously applied, the ideal of agricultural rehabilitation will be attained years earlier.

* Abstract from " Farming in South Africa "

WEED CONTROL . . .

JOHNSON GRASS
SORGHUM HALEPENSE (LINN.) PERS.

DECLARED NOXIOUS WEED

By T. L. MUNE AND J. W. PARHAM

Johnson grass is a declared primary noxious weed for the whole Colony except in the Province of Ba, Viti Levu and the tikina of Labasa, Vanua Levu, where it is a secondary noxious weed.

A moderately tall, broad leaved plant with a spreading flower-head. The spikelets are often either purple or tinged with purple and some have short, bent awns.

It is a recognised pest of cultivated lands and is not relished by stock.

BOTANICAL DESCRIPTION.

Sorghum halepense (Linn.) Pers. *Family*: *Gramineæ*.

Common Name : **Johnson Grass.**

(*Holcus halepensis* Linn ; *Milium halepense* Cav ; *Andropogon halepensis* Brot ; *A. sorghum* subsp. *halepensis* Hack ; *A. halepensis* var. *anatherus* Piper).

Perennial—Culms slender to moderately stout, 18 to 48 inches (45.7 to 122 cm) high, from a long creeping rhizome. Blades narrow, 6 to 20 inches (15.2 to 52 cm) long and ¼ to ¾ inch (3.3 to 19 mm) wide. Panicle open, narrowly ovate to oblong, 6 to 12 inches (15.2 to 30.5 cm) long and 1 to 3 inches (2.6 to 7.6 cm) wide. Spikelets sessile and stalked. Sessile spikelets oblong-lanceolate, approximately 1/5 inch (5 mm) long and 1/10 inch (2.5 mm) wide, tawny to purple tinged, slightly hairy with a deciduous, geniculate awn about ½ inch (1.3 cm) long ; stalked spikelets lanceolate, 1/5 to ¼ inch (5 to 6.6 mm) long, pale to deep purple.

Distribution—A native of tropical Asia which was originaly described by Linnæus in 1753 from a Syrian specimen. It is now widespread in many tropical and warm regions of the world. Johnson Grass was introduced to Fiji in 1905.

CONTROL.

Johnson Grass is a persistent perennial, a prolific seeder which also spreads vegetatively by underground stems. The first step towards its control is the prevention of seeding by mowing, hand cutting, digging or cultivation. Where cultivation is practised care should be taken to prevent the underground stems from being carried from the infested area on to clean ground. Failure to do this will extend the area of infestation.

Small infestations on light soil may be controlled by digging.

Repeated mowing or cutting will reduce the root stock as well as prevent seeding.

A number of chemicals have been tried on Johnson grass. The most promising of these for many years was sodium chlorate, used as a spray, and containing one pound of chlorate to one gallon of water, applied when the plants were in full flower or in the soft seed stage, at a rate of one gallon to ten square feet.

More recently trichloroacetic acid has been used with satisfactory results. T.C.A. is applied as a solution of one pound in one gallon of water, at a rate of eighty to one hundred and twenty pounds per acre. The application should be made following rain when the soil is thoroughly wet. Where possible pre-treatment such as mowing, hand cutting, or light cultivation should be carried out to enable the T.C.A. to be applied to the root system. Stock should be kept off the sprayed area as the dried plants are claimed to contain prussic acid. Johnson grass is also said to be poisonous in its young stages and when stunted by drought.

REFERENCES.

Robins, Craft & Raynor—" Weed Control ".
Hitchcock, A. S.—" Manual of the Grasses of the United States ".

" Sorghum halepense (Linn.) Pers. JOHNSON GRASS (a) Habit x 1/4 ; (b) Creeping rhizome x 1/4 ; (c) Inflorescence x 1/4 ; (d) Spikelet x 7.5.

THE UTILISATION OF SHARKS*

Practically every part of the shark has a value. For instance : the hide can be utilised as a source of leather ; the livers produce an oil often rich in vitamin A ; the fins are highly esteemed by the Chinese and others as a delicacy ; the white meat, either fresh or salted, of most kinds of sharks is a wholesome food ; while any meat unfit for human consumption can be converted into animal feed and fertiliser.

For the establishment of a shark fishing industry on a sound commercial basis, it would seem necessary to utilise the sharks completely and to give great attention to the preparation of the various products. This has been recommended in British Honduras and the Cayman Islands, for instance, where shark fishing has been carried on in the past mainly for the skins. It would appear that in the case of British Honduras at least, both the quality and quantity of the skins produced were not high and the industry not very remunerative. If an attempt were made to improve the mode and place of fishing and to prepare other products such as the oil, flesh, etc., in this area, it has been estimated that the returns from the industry would be greatly increased. In Cuba, where shark fishing has been comparatively well organised in recent years, there were in 1947 three complete processing plants in operation, about twenty collecting stations and two oil-rendering plants. The value of the exported shark products from Cuba in 1946 amounted to $13,300, and during the five year period 1942-1946 the average annual output was 11,000 skins, 18,000 lb of dry fins, and about 500,000 lb of liver oil.

Sharks deteriorate very quickly after catching and the various products become valueless unless preparation is started as soon as possible. Some species spoil more quickly than others but any shark will spoil in 24 hours, or considerably less in a hot climate. Often live fish are put in the well of the ship and not killed until arrival on shore, when processing is begun immediately. It has been found that if the sharks are left to die on the deck and processing is delayed, both the flesh and the livers darken and deteriorate rapidly. Even the skins are reported to lose half their value if skinning is delayed for more than six hours unless the shark is subjected to immediate deep freezing. In the processing of shark products it is recommended that everything should be kept scrupulously clean and washed down, and when salt is used it should be of high quality and completely free from any pink tinges. Exposure of any of the products, except the fins, to strong sunlight should also be avoided.

SHARK OIL.

Shark oil is prepared chiefly from the liver, which usually weighs about one-fourth of the total weight of the fish. A greater yield of oil is obtained from the tiger or leopard shark than from most other species. An average size shark is reported to yield about four gallons of oil. The composition of the oil is extremely variable, particularly with regard to vitamin A content, which can vary from nil to as high as 160,000 I.U. per g. according to the species. The great bulk of sharks, however, yield an oil containing 1,000 I.U. or less of vitamin A per gram.

The use of shark oil for medicinal purposes has been known for a great number of years. It is interesting to note that shark liver oil was being produced in the Madras Presidency of India in the 1860's long before the discovery of vitamins. A report published in 1873 shows that some 5,000 lb of medicinal oil, obtained mainly from sharks, was being produced annually. About 1870, however the cost of imported cod liver oil fell below that of the Indian fish oils and the industry declined, as it could not compete with the imported product.

* Abstract from Colonial Plant and Animal Products, Vol. II (1951).

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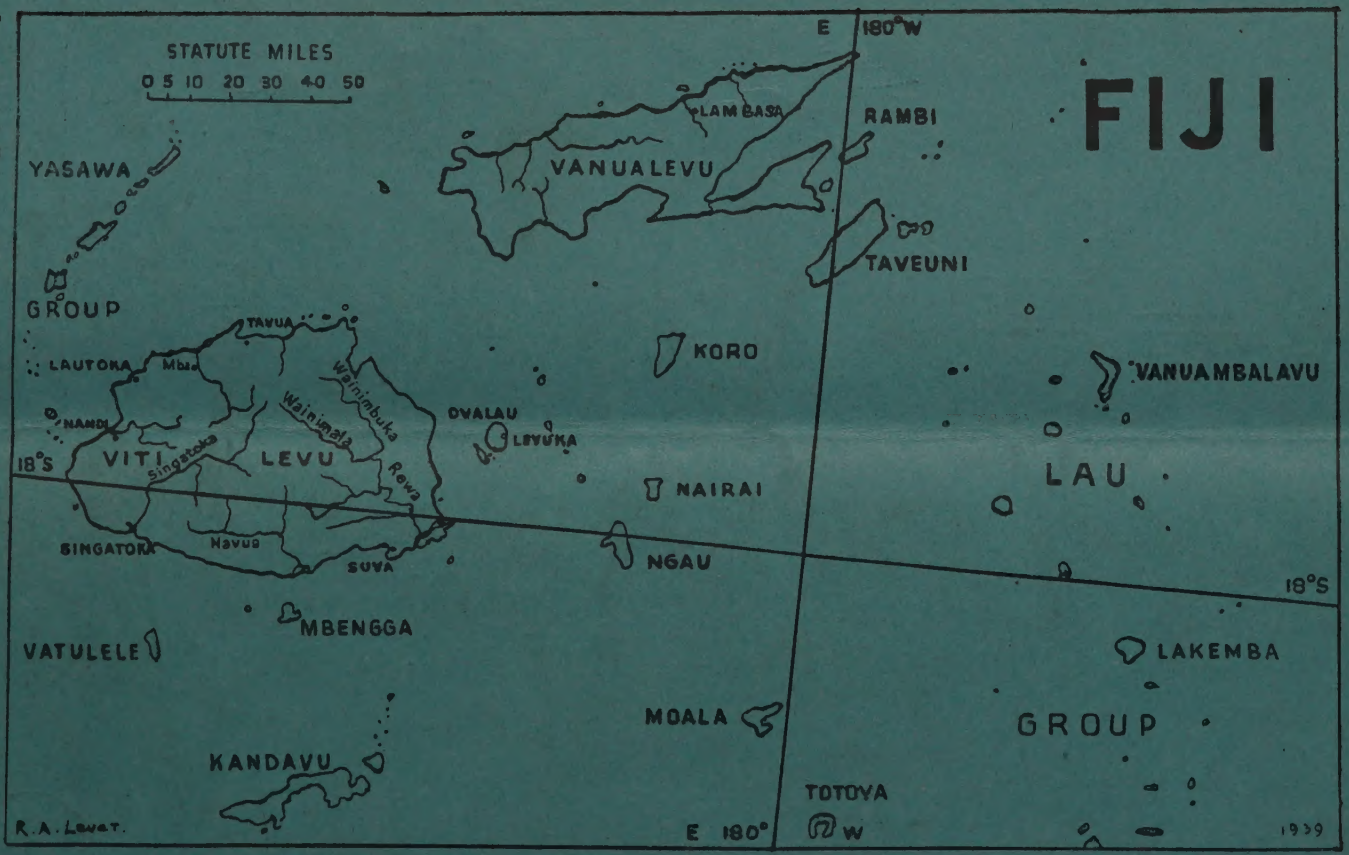

So as to include Kadavu and Totoya within the framework available the map has been rotated some 6° to the east.